U.S. ARMY
MATERIEL COMMAND

U.S. ARMY
TEST AND EVALUATION
COMMAND

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TECOM Project No. 7-CO-M97-AVD-002

FINAL REPORT

METHODOLOGY INVESTIGATION

RAH-66 COMANCHE AIRCRAFT SURVIVABILITY EQUIPMENT (ASE)

VIRTUAL PROVING GROUND (VPG) RISK REDUCTION

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ATTN: AMSTE-TM-T
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TRADE NAMES STATEMENT

DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005-5055

REPLY TO
ATTENTION OF

AMSTE-TM-T (70-10p) 25 Feb 98

MEMORANDUM FOR Commander, U.S. Army Aviation Technical Test Center, ATTN: STEAT-FT (Ms. Matthews), Fort Rucker, AL 36362-5276

SUBJECT: Final Report, Methodology Investigation, RAH-66 Comanche Aircraft Survivability Equipment (ASE) Virtual Proving Ground (VPG) Risk Reduction, TECOM Project No. 7-CO-M97-AVD-002

1. Subject report is approved.

2. The TECOM point of contact is Ms. Cyndie McMullen, AMSTE-TM-T, tmt@tec1.apg.army.mil, DSN 298-1469.

FOR THE COMMANDER:

C. DAVID BROWN, Ph.D.
Chief, Simulation and Technology Div
Directorate for Technical Mission

REPORT DOCUMENTATION PAGE

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13. ABSTRACT (Maximum 200 words) The objective of the RAH-66 Comanche aircraft survivability equipment (ASE) virtual proving ground (VPG) risk reduction methodology investigation is to develop a method that will allow an ASE system to be tested before it is installed onto the airframe. The goal is to develop a computer model of a generic ASE sensor that the user can configure to match the exact characteristics of the sensor to be integrated onto the airframe. The computer model would allow the user to place the sensor onto a high fidelity model of any airframe. The model will perform obscurance mapping to determine if any airframe components will interfere with operation of the ASE sensor.

14. SUBJECT TERMS Aircraft survivability equipment (ASE)

Virtual proving ground (VPG)	Computer model
Aircraft survivability equipment sensor	Airframe model
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FOREWORD

The U.S. Army Aviation Technical Test Center (ATTC) was responsible for planning, execution, and reporting of this methodology investigation. All data for this report are filed at ATTC under TECOM Project No. 7-CO-M97-AVD-002.

ATTC gratefully acknowledges the contributions of Mr. Kurt Lessman, AMTEC Corporation.

SECTION 1. SUMMARY

1.1 BACKGROUND

In January 1995, Headquarters (HQ), U.S. Army Test and Evaluation Command (TECOM) established the Comanche Virtual Proving Ground (VPG)/Comanche Integration Working Group with the U.S. Army Aviation Technical Test Center (ATTC) as the chair. This group's purpose was to identify potential test areas in which to apply VPG concepts to the Comanche development program. In 1996, ATTC started development of a computer model of the AN/AVR-2A laser warning system under this VPG effort. In 1997, the AN/AVR-2A computer model was combined with the RAH-66 Comanche aircraft survivability equipment (ASE)/target acquisition system (TAS) range development project. The short-term goal of this effort was to develop an ASE test range by integrating aircraft and ASE models, thus enabling developers to virtually test performance and integration of the ASE. The midterm goal was to integrate live threats and models into the ASE test range and expand the capability to allow sensor end-to-end performance testing between flight simulators and hardware-in-the-loop (HWIL) simulations. The long-term goal was to develop a realistic operational battlefield test capability for ASE end-to-end testing.

1.2 PROBLEM

Currently, ASE systems are tested after the system has been integrated onto an airframe. Sensor location is determined by attempting to place the sensor in a location that is both structurally strong enough to support the sensor and allows the sensor an unobstructed view. If problems are found during flight testing, system modifications must be made, and the flight test must start over. This methodology has to be followed on each airframe and can be very expensive and time-consuming.

1.3 OBJECTIVE

The objective of this investigation is to develop a method to test the ASE system before it is installed onto the airframe. The goal is to develop a computer model of a generic ASE sensor that the user can configure to match the exact characteristics of the sensor to be integrated onto the airframe. The computer model will allow the user to place the sensor onto a high-fidelity model of any airframe and perform obscurance mapping to determine any airframe components that could interfere with the operation of the ASE sensor.

1.4 PROCEDURES

a. In May 1996, ATTC began development of a physics-based computer model of an AN/AVR-2 laser detection sensor. Stanford Research Institute (SRI) was contracted to develop the software needed to simulate the laser detection sensor and perform obscurance analysis. Under this contract, SRI developed a computer program that will allow a user to configure a

sensor and place it onto a faceted model of any airframe. SRI assisted in selection of a computer system to host this model. The Intergraph TDZ-410 system, running Windows NT, was selected to host the ASE model.

b. ATTC contracted with U.S. Army Redstone Technical Test Center (RTTC) to provide their digital terrain data base and digital target models that are under development. RTTC would assist in the selection of a laser attenuation model and make their virtual range viewer (VRV) distributive interactive simulation (DIS)-compliant. When the model was operational, a joint test effort would be planned with RTTC. Using the ASE model, AN/AVR-2 sensors would be placed onto a faceted model of an AH-64 and oriented correctly. The ASE model would replicate a flightpath over one of RTTC's digital ranges. By using the VRV, a participant would be able to enter the range at an exact location. The VRV would be configured to simulate a laser emitter. A participant would attempt to designate the AH-64 as it followed its flightpath. Upon VRV trigger pull, angle and signature information would pass to the ASE model through DIS protocols. From this information, the ASE model would determine if the sensors detected the laser beam. A validation and verification (V&V) effort would be performed by placing an emitter on the actual range in the exact same location and orientation as in the computer model; then, an AH-64 would fly the same flightpath as in the computer model. The data could be compared between the actual and simulated flights.

1.5 RESULTS

a. The first Intergraph system with the ASE model installed was delivered in February 1997. The ASE model allowed the user to configure a generic sensor and place it on a faceted model of an airframe. The model allowed the user to place up to four sensors on the airframe. After placing the sensor in the desired location, the user was required to orient the sensor to provide the correct azimuth and elevation angles to ensure that the sensor had the correct field of view. The only faceted airframe model supplied with the ASE model was an 80,000-facet model of an AH-64. The fidelity of this model was appropriate, but the accuracy was questionable. ATTC was unable to find a more accurate model for use.

b. SRI's ASE model did not provide the ability to place the airframe in a virtual environment; additional software had to be purchased to do this. A simulation development program named ExoDIS was purchased to provide a user-configurable virtual environment that allowed the user to view the ASE model in a defined environment. ExoDIS allowed use of the RTTC digital terrain data base as one of the virtual environments in which a system could be tested. RTTC has identified several laser attenuation models that could be used; however, one has not yet been integrated into the ASE model.

1.6 ANALYSIS

a. A graphical user interface provides a windows environment to work in. The user selects a faceted airframe model on which to integrate sensors from a data subdirectory. Once

the faceted model is loaded into memory, the user can toggle through different views to assist in the integration of the sensor. Available views are: x-axis (looking at the nose of the aircraft); y-axis (looking down at the rotor head from above); and z-axis (looking at a side view of the airframe). The ASE model does not allow the user to zoom in and out on the airframe, which makes it difficult for the user to correctly place and orient sensors. Initially, a sensor is placed orthogonal to the surface of the airframe at the point the user selects. The user has to enter x, y, and z coordinates that describe the orientation of the sensor. Once a sensor is placed and oriented and the user confirms the input, the model generates a red pointer from the center of the sensor in the direction the user has defined. The user does not have the ability to edit any of these sensor parameters in the current operating environment. To change the parameters for the sensor, the user would have to edit the configuration file for that specific simulation. Once all the sensors are placed and oriented, the user is prompted to run an obscurance analysis to determine if any airframe components degrade the view of the sensor. Upon completion of the analysis, the user may view a map of each sensor. The map is oriented as if the user is looking straight down the center of the sensor--areas in green are not obstructed and areas in red are blocked. The user must then go back to the model with the sensors installed to try to determine what is blocking the sensor's view. This can be a difficult task since the airframe model is at a fixed distance and can only be rotated through orthogonal views.

b. The airframe model with sensors installed can be exported into the ExoDIS virtual environment, which allows the user to view the airframe in flight over a user-defined environment. A routine was added to the ExoDIS program that takes sensor information from the ASE model and uses it to generate translucent cones from the sensors mounted on the airframe. The cones will change color upon detection of emitter beams. The user can place emitters in the environment by use of ExoDIS utilities, and flightpaths can be input from recorded flight data, global positioning system (GPS) coordinates, or computer simulation. The digital terrain model loaded into the ExoDIS determines the geographical location of the simulation. Currently, the program uses the RTTC range as the location for the simulated flight.

1.7 CONCLUSIONS

a. The ASE model does not provide the user with the ability to accurately place and orient sensors onto the airframe. To correctly place the sensor, the user needs the ability to zoom in and out on the airframe model. Airframe rotation beyond orthogonal views would also enhance the user's ability to correctly place the sensor. A reference system is needed that will allow the user to easily transfer sensor locations from the model to an actual airframe and from an actual airframe location to the test model.

b. After a sensor has been placed and oriented onto an airframe, the user needs the ability to edit both the location and the orientation of that sensor without leaving the configuration environment. A unit vector that the user provides describes sensor orientation. The unit vector was not an intuitive method for describing the orientation of the sensor, so a program was provided that allows the user to enter the view angles of the sensor and it generates the unit vector to be entered into the ASE model. The ASE model's map of sensor blockage does not

provide the user with a reference to what airframe component is causing the blockage. To determine the cause of interference, the user has to regenerate the model under test and try to determine from observation what airframe component is interfering with the sensor field of view.

c. ATTC and RTTC investigated the need to perform interactive virtual testing and could not identify any customer requirements that would justify the demonstration of this capability. After this investigation, the decision was made to end the effort to make the virtual range view DIS-compliant.

1.8 RECOMMENDATIONS

Develop an interface that will allow the user to change both view angle and view location to allow for better placement of the sensor. Provide the user with a coordinate system that can be referenced back to an actual airframe. Develop a more intuitive means by which to orient the sensor. Incorporate an editing feature that will allow the user to change the location of, or parameters associated with, the sensor after it has been placed on the airframe. Interface a laser attenuation model to account for atmospheric conditions. Develop a routine that will allow the user to determine the optimum location for placement of a sensor. Purchase or build additional high-fidelity models of each airframe type for use with the ASE model. Purchase or build additional digital ranges to use within the ExoDIS simulation software in order to provide a broader virtual test environment. Provide additional training on the use of the ExoDIS software package.

SECTION 2. DETAILS OF INVESTIGATION

Not Used

SECTION 3. APPENDIXES

APPENDIX A. TEST EXECUTION DIRECTIVE FY97 METHODOLOGY PROGRAM

APPENDIX B. ABBREVIATIONS

APPENDIX C. DISTRIBUTION LIST

DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005-5055

REPLY TO
ATTENTION OF

01 OCT 1996

AMSTE-TM-T (70-10p)

MEMORANDUM FOR Commander, U.S. Army Aviation Technical Test Center, ATTN: STEAT-TS-P, Fort Rucker, AL 36362-5276

SUBJECT: Test Execution Directive, FY97 Methodology Program

1. Reference TECOM Pamphlet 70-15, 11 Feb 93, Research, Development, and Acquisition - TECOM Test Technology Procedures.

2. This memorandum authorizes the execution of the projects listed in enclosure 1 under the TECOM Methodology program. Detailed project descriptions listed in the FY97 TDAP database are the basis for headquarters approval of the projects.

3. Upon receipt of this directive, review TRMS II database test milestone schedules established for the projects and enter any necessary reschedules directly into the TRMS database with appropriate justifying narrative.

4. All safety, health, energy and environmental issues associated with the project will be considered and necessary documentation or support studies/information/approvals required will be accomplished/prepared prior to project initiation. Security/OPSEC requirements will be adhered to.

5. All reporting, including final technical reports prepared by contractors, will be in accordance with the requirements and appropriate formats as specified in the reference. Final reports will be reviewed and approved by the TECOM Directorate for Technical Mission.

6. FY97 RDTE funds authorized for the projects are listed on enclosure 1. GOA Form 1006 will be forwarded by the TECOM Resource Manager, and will be updated to reflect all changes to current program. Submit a cost estimate within 30 days following receipt of this directive.

7. Submit requests for reprogramming to AMSTE-TM, ATTN: Ms. Cyndie McMullen. Also, submit monthly reports in accordance with reference 1, para 3-7a.

8. Point of contact at this headquarters is Ms. Cyndie McMullen, AMSTE-TM, amstects@apg-9.apg.army.mil, DSN 298-1469.

FOR THE COMMANDER:

Encl

C. DAVID BROWN, PhD
Chief, Simulation & Technology Division
Directorate for Technical Mission

CF(w/encl):
Cdr, USAATTC, ATTN: STEAT-TS-D (Mr. L. Martin)/STEAT-RM-B

FY97 D628 METHODOLOGY PROGRAM

	AVIATION TECHNICAL TEST CENTER	INITIAL FUNDING
7-CO-M97-AVD-001	FY97 TECHNICAL COMMITTEE SUPPORT	5.0
7-CO-M97-AVD-002	VPG RAH-66 COMANCHE ASE VPG RISK REDUCTION	170.0
7-CO-M97-AVD-003	VPG RAH-66 FTSS	300.0

	TOTAL ATTC PROGRAM	475.0

Encl

APPENDIX B. ABBREVIATIONS

ASE	- aircraft survivability equipment
ATTC	- U.S. Army Aviation Technical Test Center
DIS	- distributive interactive simulation
GPS	- global positioning system
HQ	- headquarters
HWIL	- hardware in the loop
RTTC	- U.S. Army Redstone Technical Test Center
SRI	- Stanford Research Institute
TAS	- target acquisition system
TECOM	- U.S. Army Test and Evaluation Command
V&V	- validation and verification
VPG	- virtual proving ground
VRV	- virtual range viewer

APPENDIX C. DISTRIBUTION LIST

ADDRESSEES	REPORT
Commander U.S. Army Test and Evaluation Command ATTN: AMSTE-TM-T Aberdeen Proving Ground, MD 21005-5055	3
Defense Technical Information Center 8725 John J. Kingman Road, Suite 0944 Fort Belvoir, VA 22060-6218	1